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US 5286939 A US 4751359 A

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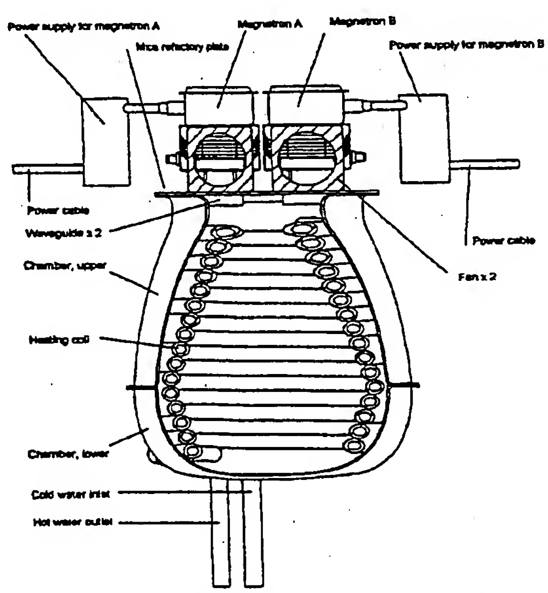
ONLINE: WPI, JAPIO, EPODOC, INSPEC

(54) Abstract Title
Microwave continuous flow water heater

(57) The :Microwave continuous flow and linear water heater consists of a closed chamber into which microwaves at a frequency of 2450 mhz. are introduced via two magnetrons, the heater being characterised by a chamber of truncated conical section having a concave base wherein no adjacent section are at right angles thus preventing generation of refraction and diffraction waves. The base of the chamber serves as a reflecting dish to direct energy towards the silica based flexible coil disposed against the chamber wall. The silica based coil is spiral led inside the chamber and is terminated to inlet and outlet glands. These provide for a continuous flow of water to pass through the coil in any direction depending upon the application and/ or the plumbing arrangements in which it is being used.

Section view with outer casework removed



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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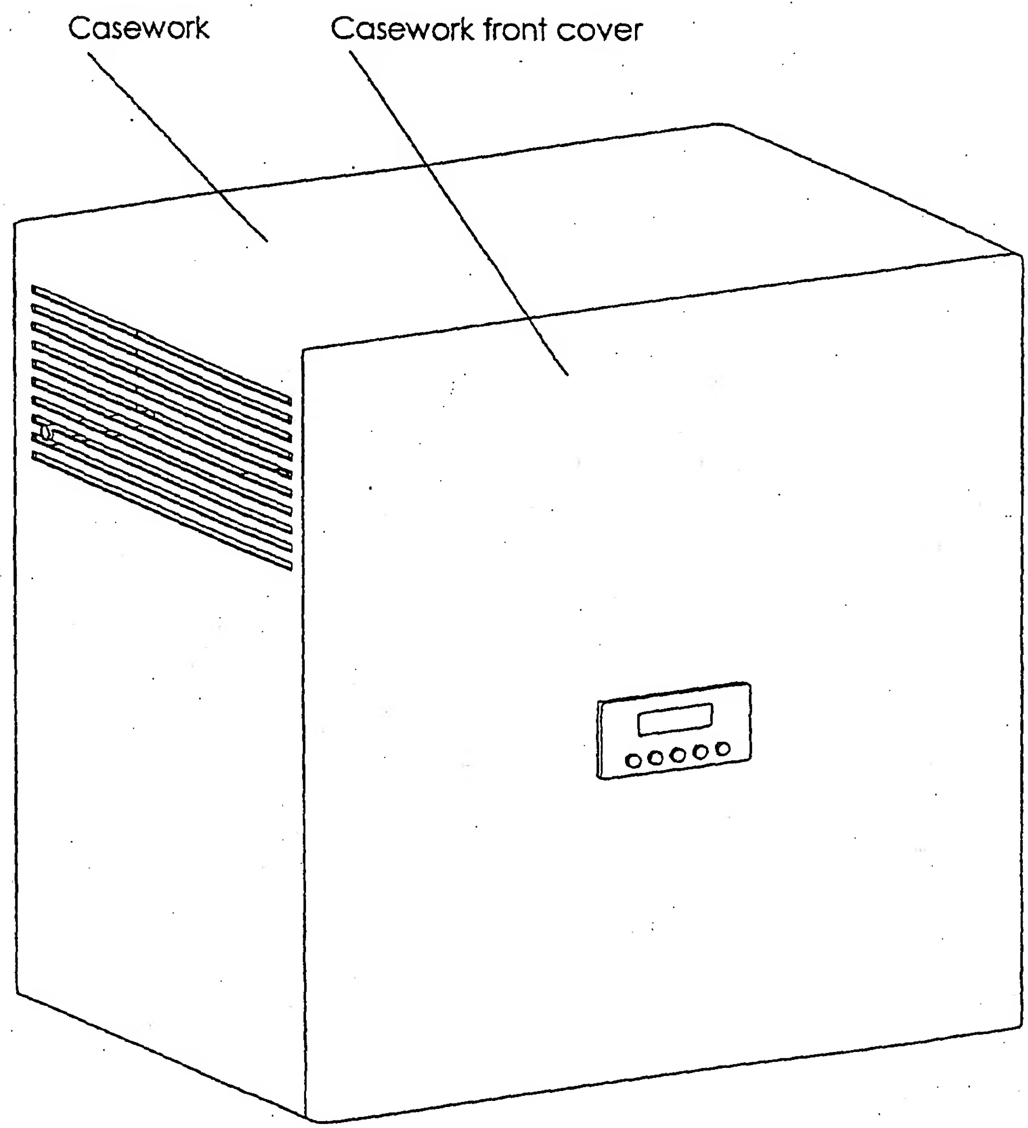
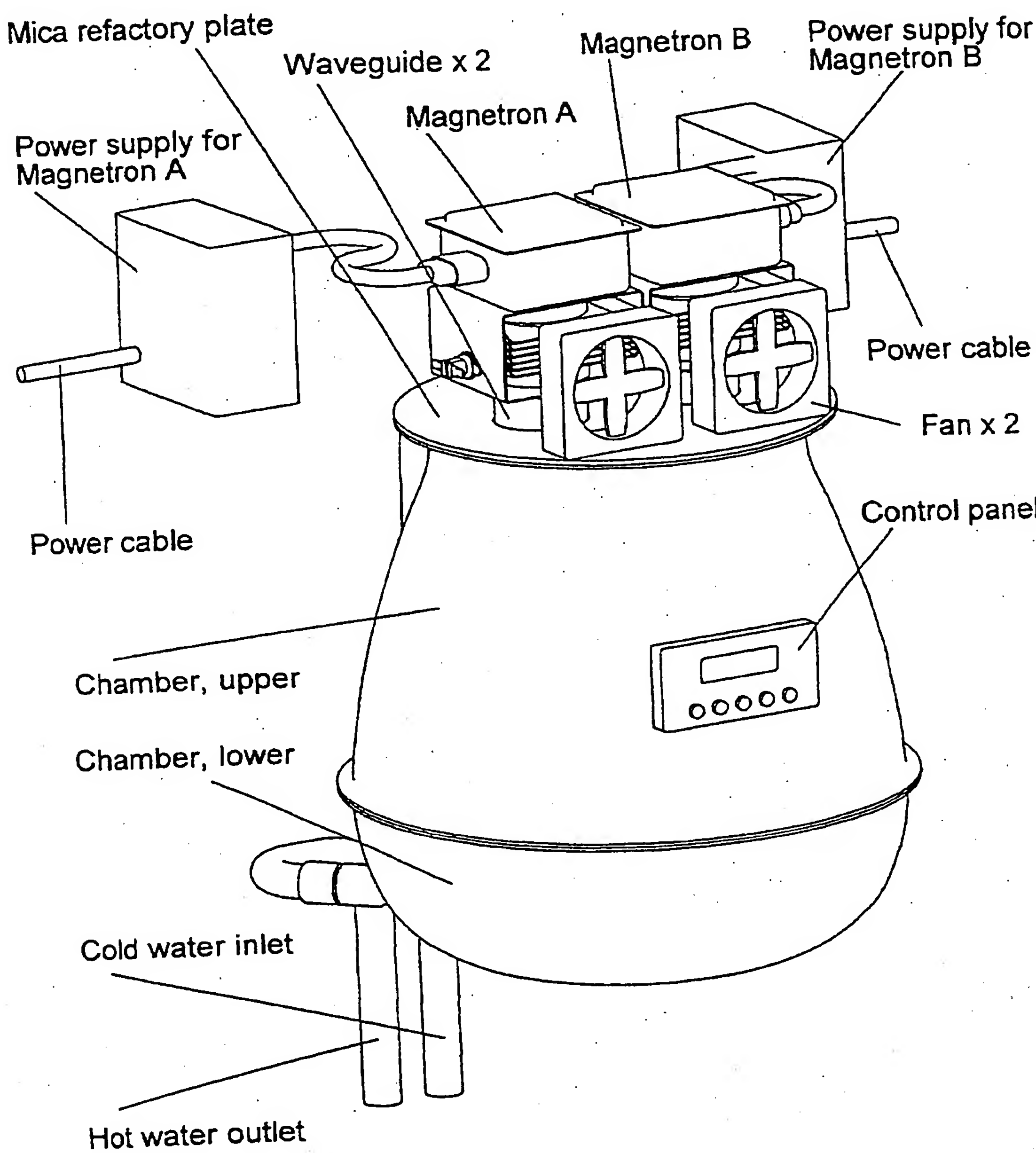
1 Microwave Continuous Flow Water Heater

Front, three quarters view showing outer case



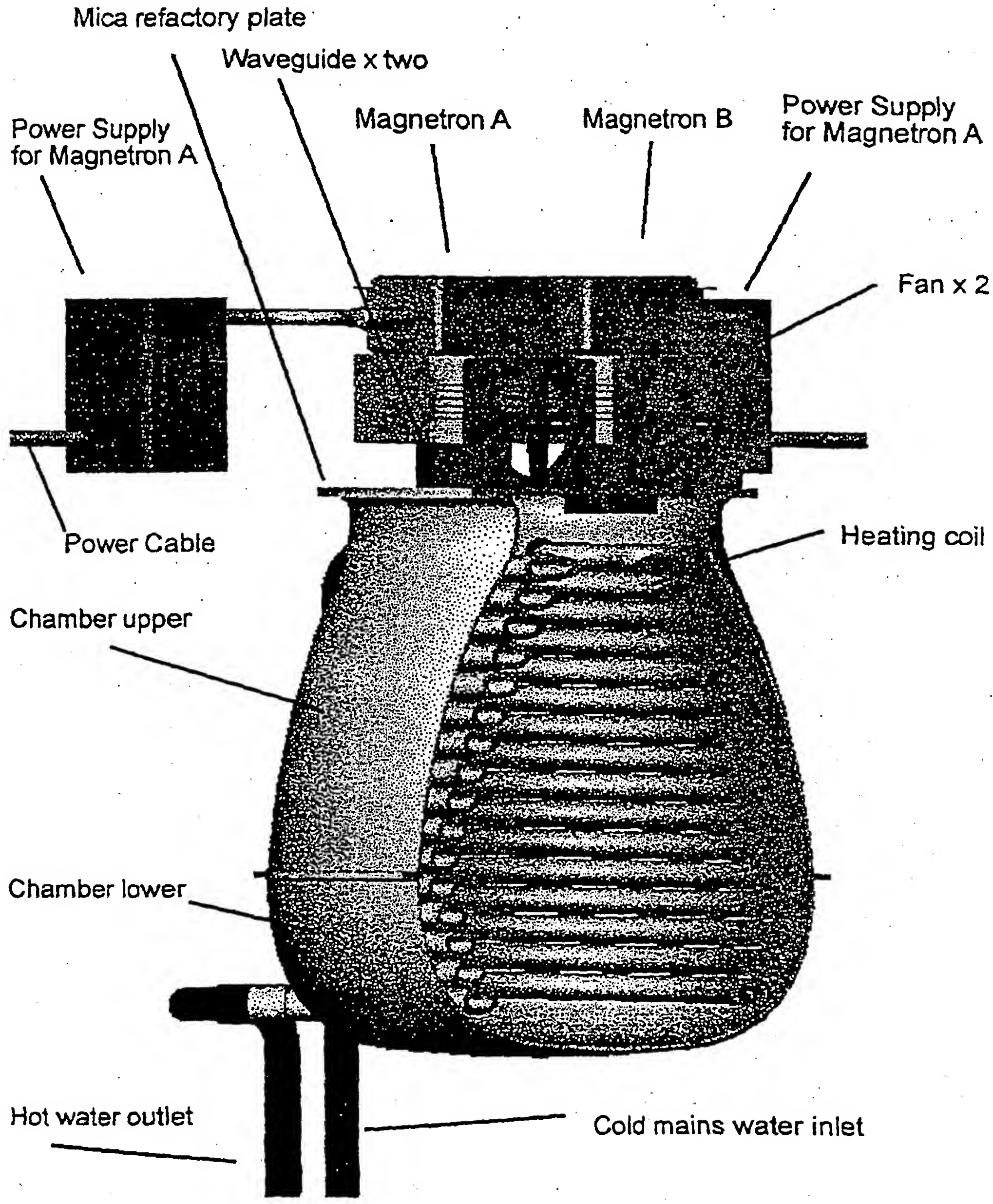
2 Microwave Continuous Flow Water Heater

Front, three quarters view with outer casework removed



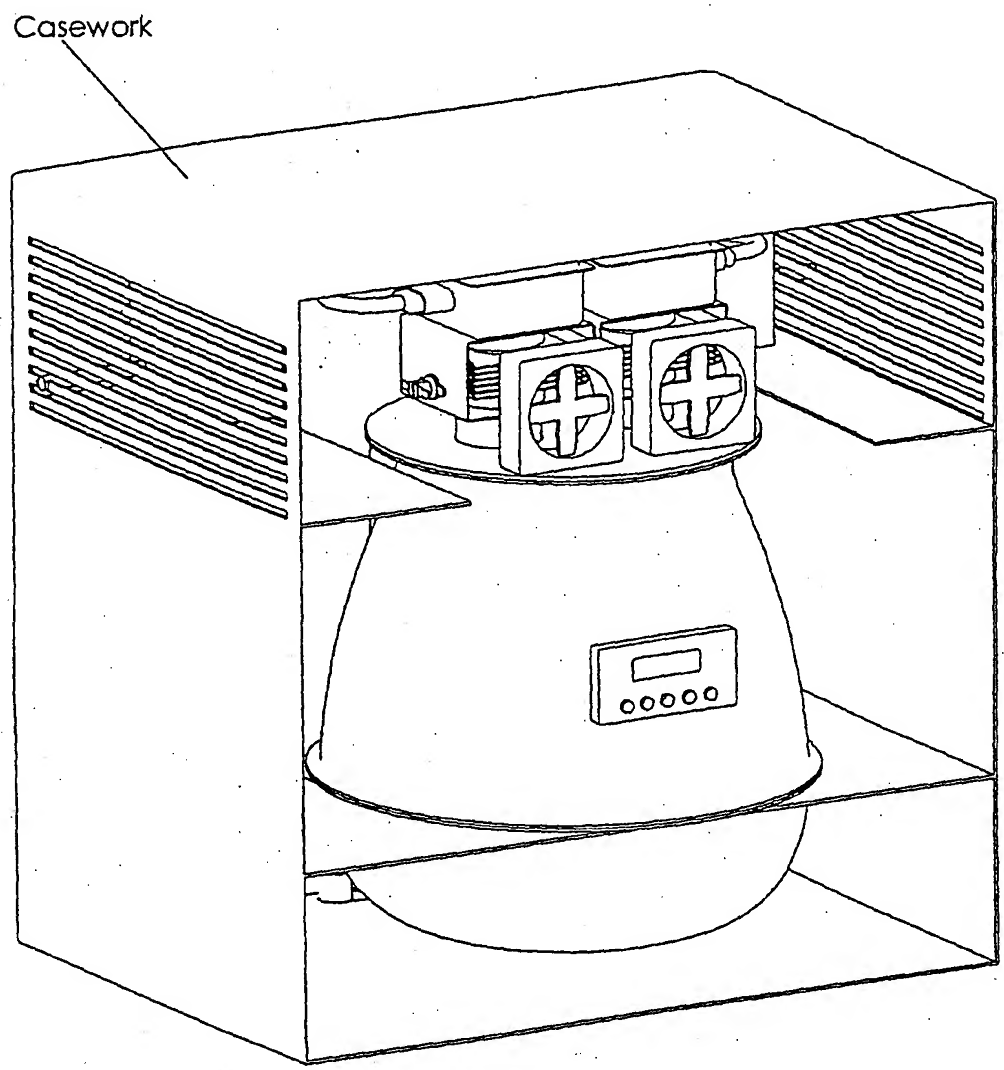
3 Microwave Continuous Flow Water Heater

Cut-away view with outer casework removed

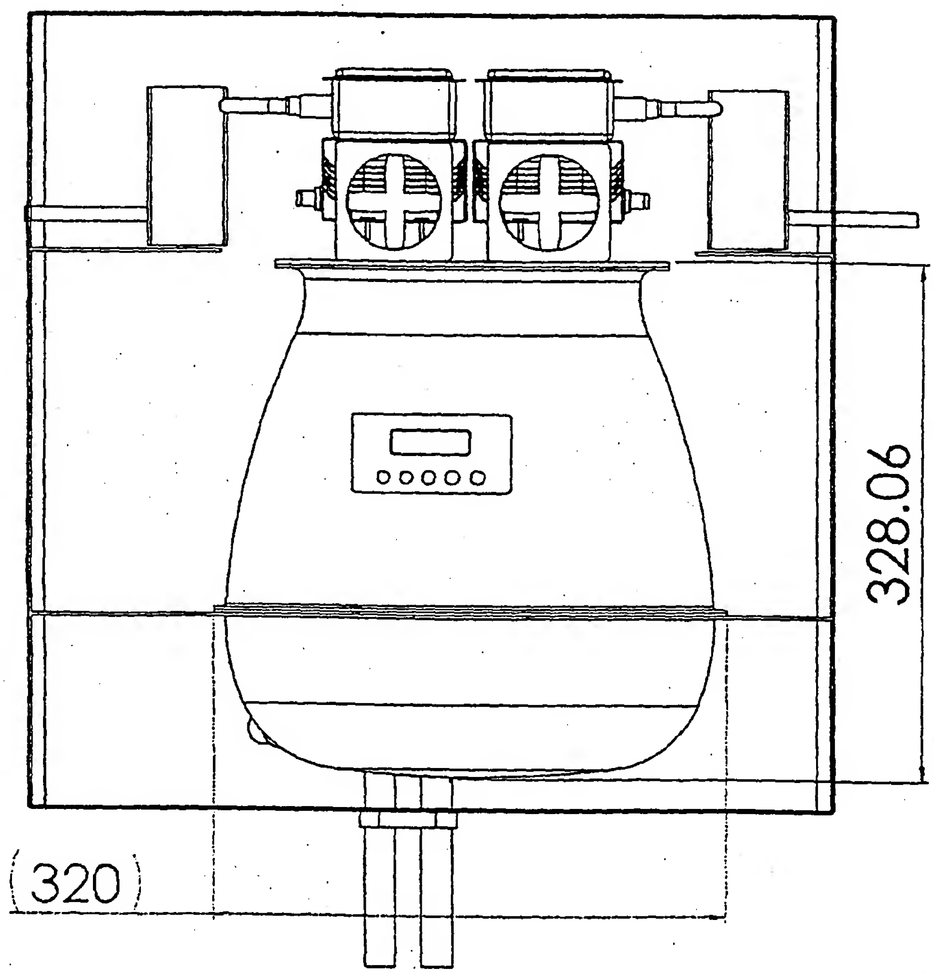


4 Microwave Continuous Flow Water Heater

Front, three quarters view with front of outer case removed



Microwave Continuous Flow Water Heater
Front View, Outer case front hidden



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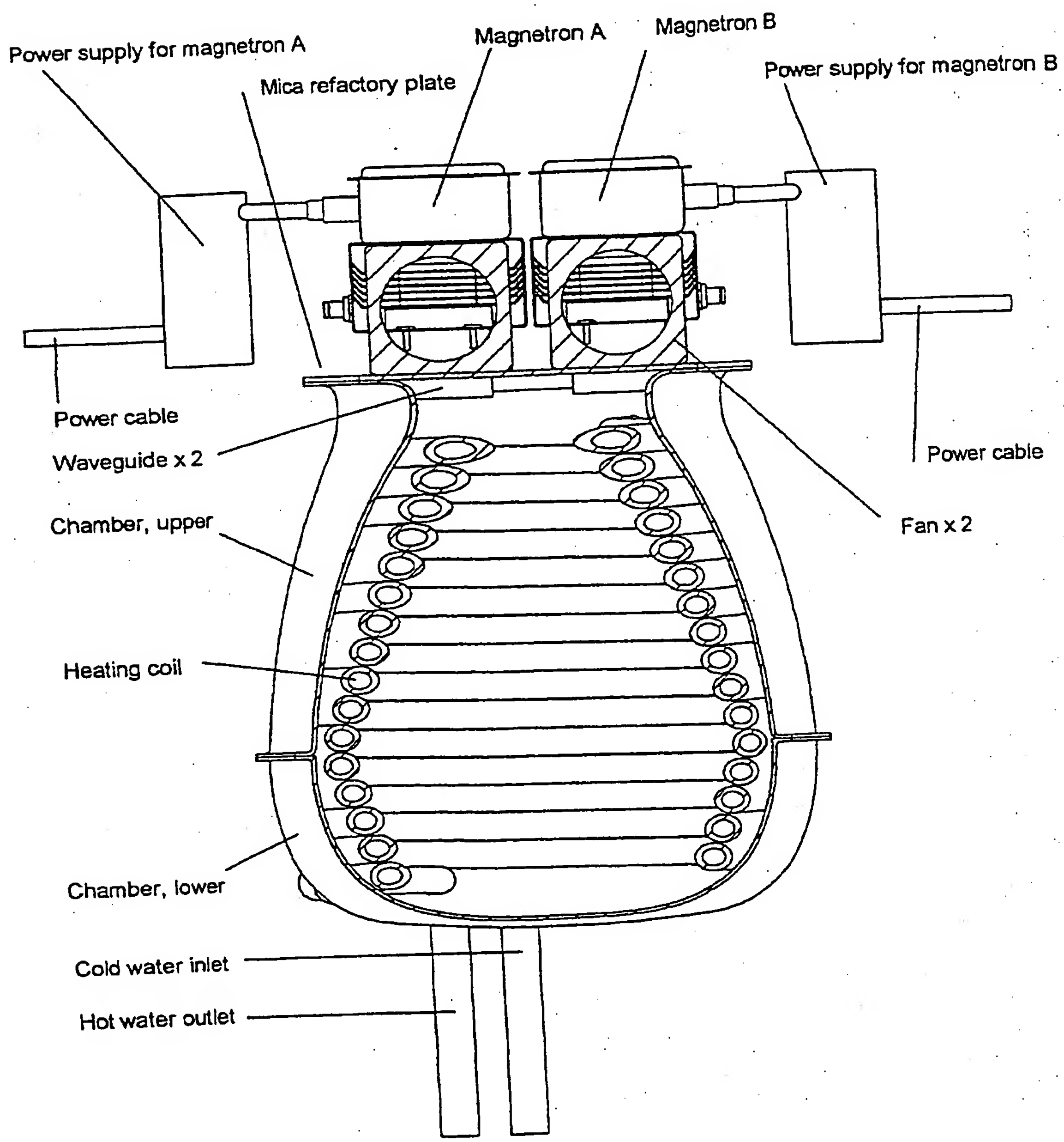
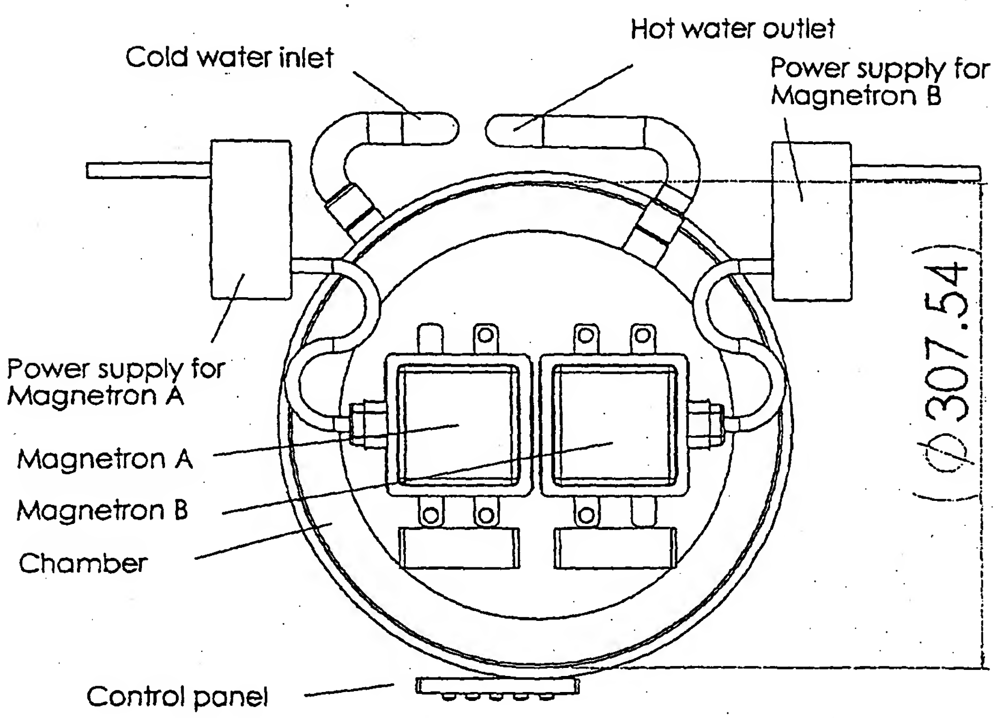
6 **Microwave Continuous Flow Water Heater**

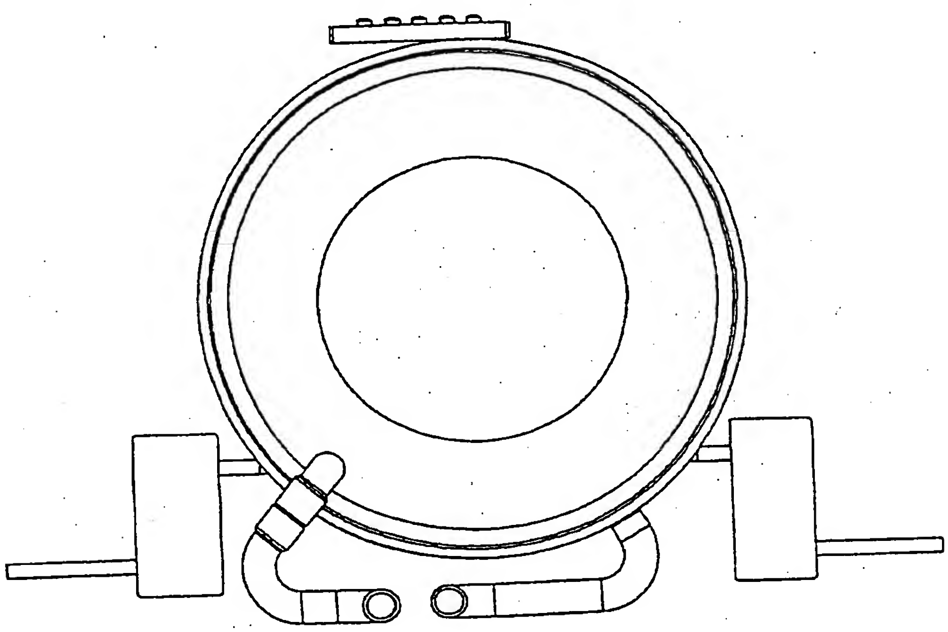
Section view with outer casework removed



7 **Microwave Continuous Flow Water Heater Top View, Outer case hidden**

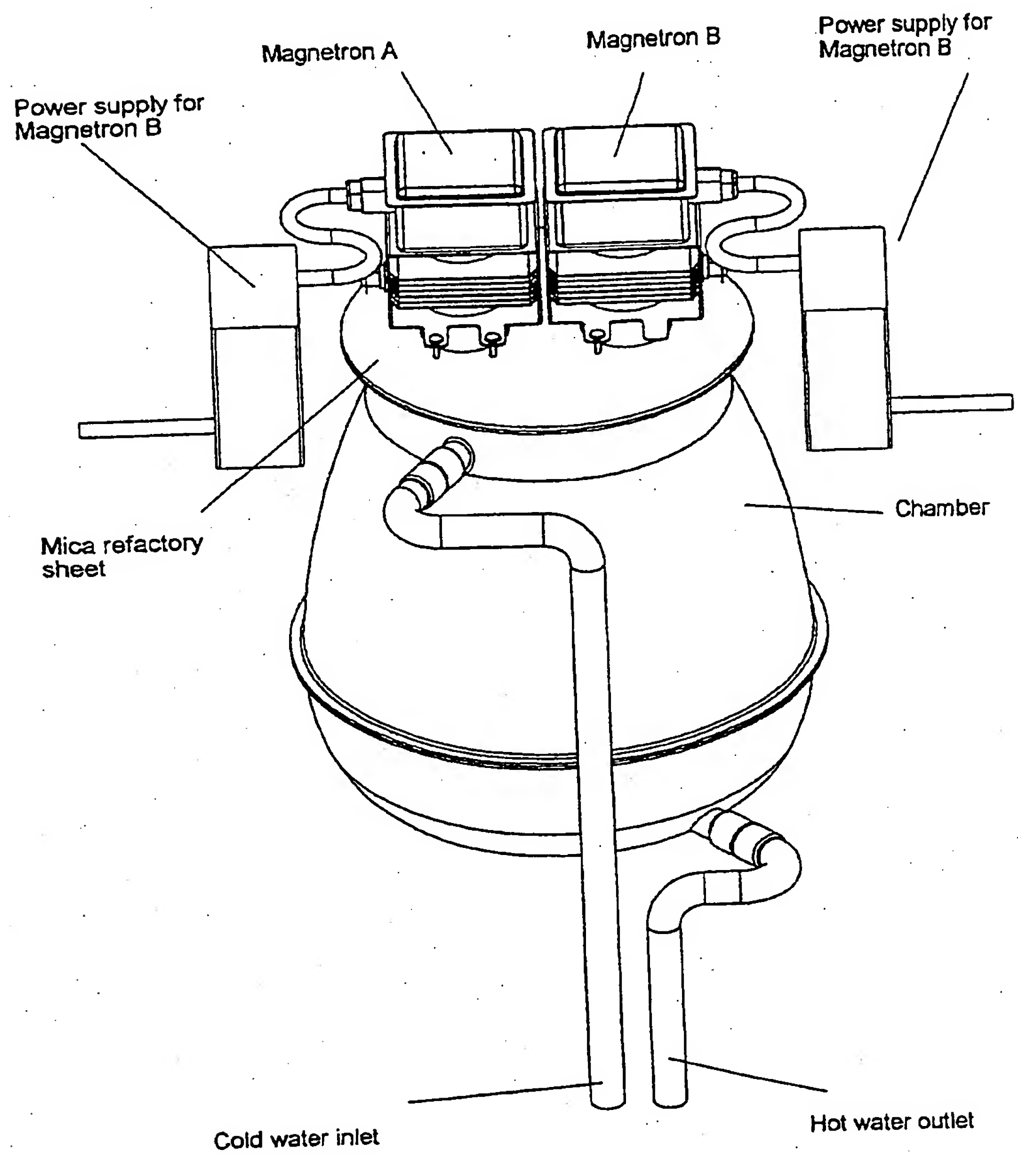


8 **Microwave Continuous Flow Water Heater Bottom View, Outer case hidden**



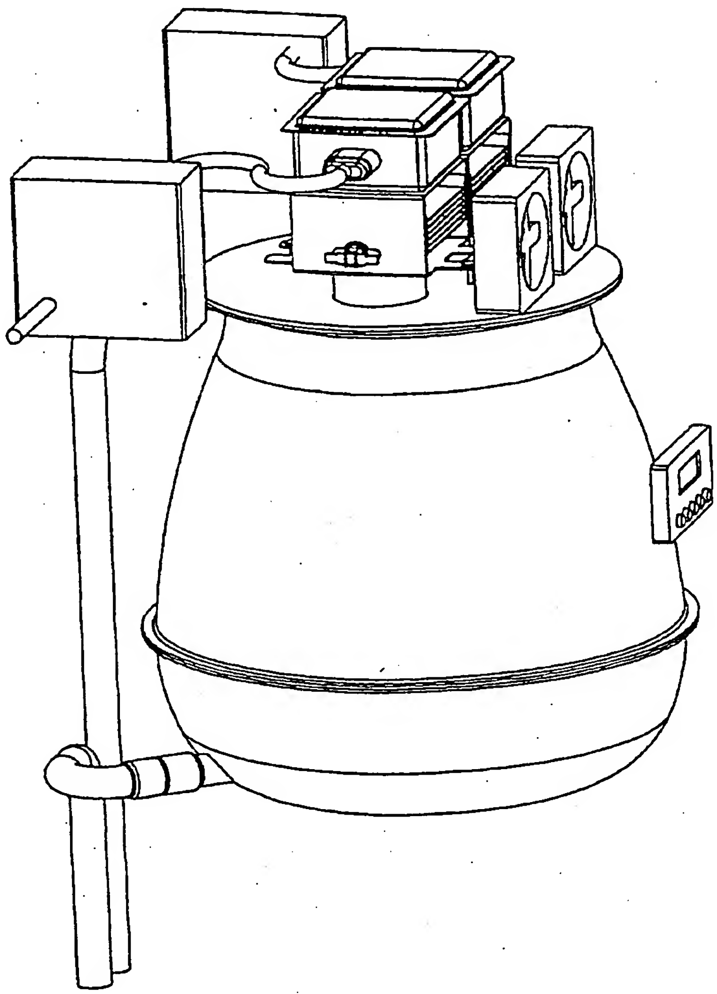
9 **Microwave Continuous Flow Water Heater Rear View, Outer case hidden**

Drawing 9



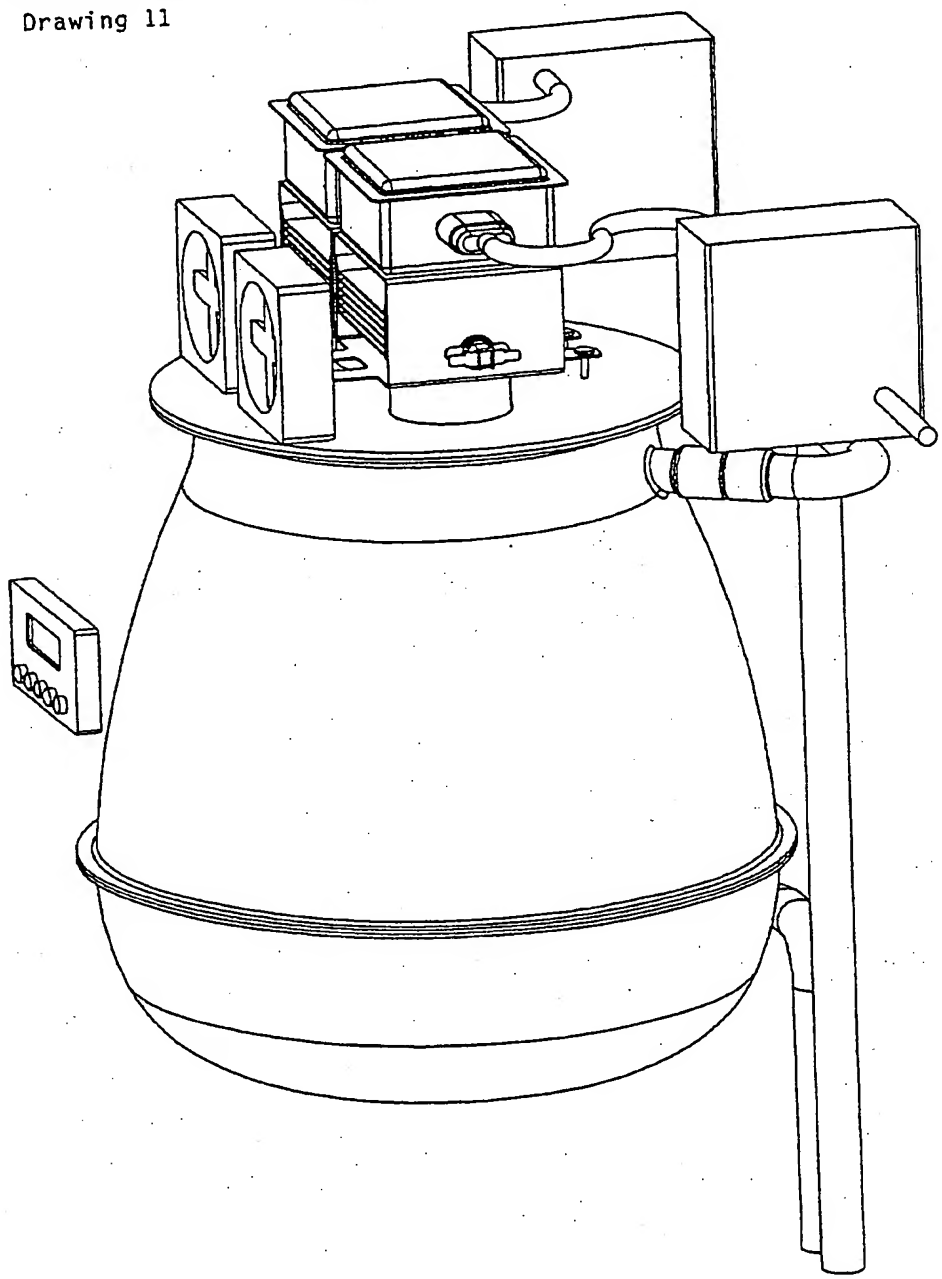
10 **Microwave Continuous Flow Water Heater Left hand view with outer case hidden**

Drawing 10

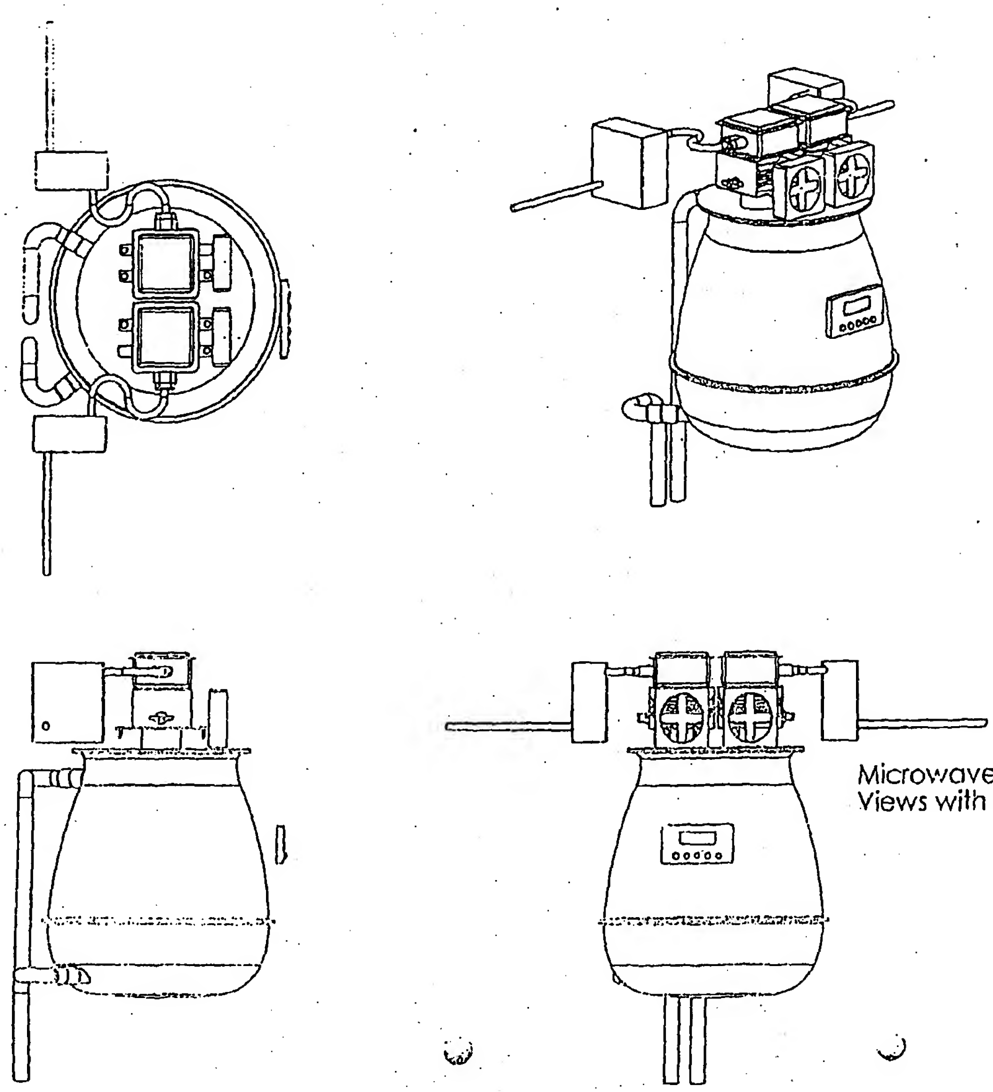


11 Microwave Continuous Flow Water Heater Right hand view with outer case hidden

Drawing 11



Drawing 12



Microwave Continuous Flow Water Heater
Views with outer case hidden

MICROWAVE CONTINUOUS FLOW WATER HEATER

Background of the Invention.

This invention relates to an apparatus that uses μwaves as a means to heat water in a continuous flow for the purpose of providing a source of domestic hot water.
There is a serious concern from a scientific, economic and environmental point of view to look into the possibility of supplying to the domestic household a more environmentally friendly, safer and economical way to supply hot water. It is a well known fact that sources of hydrocarbons will, in the near future, start running low and therefore other forms of energy must be found; electricity generated by other means than by burning fossil fuels e.g. nuclear energy or natural source energy (wind or hydro-power etc.) is the obvious answer. Coupled with this there is the environmental impact that burning fossil fuels has in general and the hazard of carbon monoxide generated locally.

The μwave heater is not only safe to operate, it has long life, it is economic to produce, maintain and install. Therefore, unlike it's fossil fuel burning alternatives, it offers the domestic household a cost-effective source of hot water and the healthier benefit of reduced, residential, water-borne bacteria (see note below) and eliminates the risk of toxic carbon monoxide exhaust gases escaping into living areas.

The μwave heater does not require bulk storage of pre-heated water (which constantly requires re-heating due to thermal loss) and consequently no immersion heater (which is costly to run) or bulky loft storage tanks. Also, because it does not require bulk water storage, the build-up of harmful bacteria will no longer be an issue. Water is presently required to be heated to a minimum of 60° Celsius to prevent bacteria build-up, but it is well known that hot water for human consumption should not exceed 39° Celsius, hence substantial energy savings will be achieved as a result.

Microwave technology has been used for many years in different fields of industrial processes, however, to the best of the inventor's knowledge, no such design of an appliance that uses μwaves as a source of heating a continuous flow of liquid (in this case water) has ever been described in scientific literature. In fact it is known that all μwave chambers generate standing waves and create a non-linear distribution of radiating energy. (the reason why μwave cooking ovens have 'stirrers' or rotating turntables)

The Continuous Flow and Linear Water Heater is characterised by a circular section conic chamber which is designed to eliminate standing waves, and a linear thermal silicone tube (Coil) (having dimension of 1cm. internal diameter) which overcomes the 'EGG-Syndrome' effect. (see Keywords)

Summary of the Invention.

1. The invention relates to a Water Heating System which will heat water to a predetermined temperature on a continuous flow basis. This system will use radiated energy at a frequency (2.45 x 10^9 Hz.) within the Micro(µ)wave band sourced from an Electron Tube (Magnetron) to heat the water.

2. The heating of water by means of µwave radiation via a conventional magnetron (electron tube) is well known. Wherein measured amounts of water is placed in suitable containers and subsequently bombarded with µwave energy inside a sealed chamber at the appropriate frequency to maximise molecular agitation resulting in a temperature rise.

3. This principle remains at the heart of this invention but in this case a continuous flow of water enters a sealed µwave chamber, remains within the chamber, and consequently within the flux of the µwave energy, for a predetermined period and emerges at a raised temperature.

4. This is achieved by virtue of a specially developed, silica based, flexible pipe or tube (somewhat resembling a garden hose) which can be coiled or wound into any desired configuration and does not therefore depend on any pre-forming (referred to in these documents as the 'Coil').
This coil is situated within a specially designed µwave chamber and connected to the outside world via an input and output gland. The time that the water remains within the coil, and hence the µwave flux, will therefore determine the temperature rise. This will be directly proportional to the rate of flow and the coil length.

5. The physical properties of the Coil are as follows:

Test.	Units.	Result.
Hardness:	IRHD	60
Specific Gravity:	g/cm^3	1.20
Tensile Strength:	MPa	7
Elongation at break:	%	500
Tear Strength:	kN/m	15
Compression set:	%	35

Cure Conditions.

Curing Agent:	DCLBP (2,4-Dichlorobenzoyl) Peroxide 50%
Curing time/temp.	300Sec. (5min) @ 116° C.
Post Cure:	4Hrs. @ 200° C.

The Coil has an estimated lifetime of 10 - 20 years and can remain within a completely sealed μwave chamber environment for this time.

6. The μwave chamber in which the coil is housed is of specific design. It is of Circular Conic Section with a dished or internally concave base. and of approx. $0.046m^3$ in volume. (see accompanying drawing)

7. The μwave chamber in this form presents no right angles and therefore does not give rise to standing waves and is designed to avoid the generation of refraction and diffraction waves. The concave base serving to reflect the μwave energy towards the sloping surface of the inside of the conic chamber.

8. The coil will be wound in helical fashion around the inside surface of the conic chamber between entry and exit glands near the top and bottom.

9. Microwave energy, generated by the two magnetrons will be introduced into the top of the chamber. Magnetrons to be of standard, commercially available, types.

The Drawings.

The following 12 drawings are included in this order:

1. Front three quarters view wtih outer casework.
2. Front three quarters view with outer casework removed.
3. Cut-away view with outer casework removed.
4. Front three quarters view with casework front removed.
5. Front view, Outer case front hidden.
6. Three quarters view with case front hidden.
7. Top view, Outer case hidden.
8. Bottom view, Outer case hidden.
9. Rear view, Outer case hidden.
10. Left hand view with outer case hidden.
11. Right hand view with outer case hidden.
12. Views (4) with outer case hidden.

Brief Description of the Drawings.

1. Front three quarters view with outer casework.

The invention, when in production, would be housed in a pressed steel case for either floor or wall mounting. Shown on this drawing are cooling vents in the casework, hot & cold water outlet and inlet pipes respectively and a typical control panel.

2. Front three quart rs view with outer casework removed.

All components are clearly labelled on the drawing. The drawing shows the assembled chamber with two, air cooled, magnetrons on the top with cooling fans. Two, half wavelength ($\lambda/2$) circular wave-guides connect the magnetrons to the chamber. The magnetron power supply components (transformer, capacitor & diode) are shown in block form.

3. Cut-away view with outer casework removed.

As drawing 2. but showing the chamber in cat-away view to show the flexible silica heating coil in position in wound helical form around the inside surface of the chamber.

4. Front three quarters view with casework front removed.

Depicts the chamber assembly in operational position within the casework. The chamber principally held in position by a slot-in shelf which supports the chamber assembly below the joining flange.

5. Front view (sketch) Outer case front hidden.

Sketch showing chamber in operational position and giving external dimensions of the prototype chamber in millimetres.

6. Three quarters view with case front hidden (sketch).

Sketch of the chamber in the operational position within the casework.

7. Top view (plan). Outer casework hidden (sketch).

A sketch plan view of the chamber assembly showing the external diameter of the chamber, and the position of the magnetrons/fans relative to the chamber. Water inlet and outlet connections can be seen at the top and bottom of the chamber assembly.

8. Bottom view. Out casework hidden (sketch).

Shows water connection to the bottom of the chamber assembly.

9. Rear view (sketch). Outer casework hidden.

Clearly showing water input and output connections to the flexible silica coil within the chamber assembly. The top of the chamber assembly will be of stainless steel and the mica refractory plate mentioned on the drawing will be positioned within the chamber at the output of the waveguides.

10. Left hand view with outer casework hidden. (sketch).

Showing the chamber assembly and top mounted components (magnetrons & fans.) from this viewpoint.

11. Right hand view with outer casework hidden (sketch).

As 10 above but seen from the right hand viewpoint.

12. Views with outer casework hidden.

Four sketch views (plan, three quarter view, left-hand & front view) of the chamber assembly with all the relevant chamber mounted components in position.

Detailed Description of the Invention.

1. The essential elements of this invention are the Circular Section Conical Chamber with a Dished Base and the Flexible Silica based Coil.

2. The Chamber will be constructed of pressed stainless steel and manufactured in two parts. The top, or conic section, with all necessary orifices and external component mounting requirements, and the dished base section which will tight fit over the bottom of the top section.

3. The flexible silica coil will be fixed into position spiralled around the internal surface of the conic section and terminated to the water inlet and outlet glands or ports.

4. Once the coil has been fitted within top section the dished base section will fit into position over the base of the cone and be sealed to create a totally RF. (μwave) leakage free joint.

5. The sealed chamber and coil assembly will be mounted into a steel framework to hold it in position. (see drawing 4) (Whilst this drawing shows the chamber/coil assembly in the vertical position in practice of course this could be mounted in any orientation.)

6. All operational electrical and electronic circuits incorporating:

(a) Power supply	(Transformers, diodes and capacitors.)
(b) Safety monitoring	(Water temp. & pressure sensors, magnetron temp. sensors & fuses.)
(c) Control components	(Timer & temp. control.)

(d) Magnetron cooling fans. (x2)

will also be mounted within the framework and totally encased within a pressed steel outer casework.

Keywords.

Chamber.	A totally sealed metal enclosure into which microwaves are introduced and the heating process is carried out and which allows no microwave leakage to the external surroundings.
Coil.	Silica based flexible tube which is situated in a μwave chamber and through which the fluid (water in this case) which is to be heated is passed.

Egg-Syndrome.	Characterised in this context by the irregularity of temperature distribution within a body of heated water.
Magnetron.	syn, Magnetron Oscillator. A free-running (unlocked) RF oscillator. A crossed field microwave tube that produces radio frequency oscillation in the microwave region of the electronmagnetic spectrum. The device that produces microwaves.
Microwave.	Propagated electromagnetic energy in the wavelength range of 3mm to 1.3m. In this particular application we are using microwaves of specific wavelength 0.12245m (12.24cm) or 2450Mhz. (2.45×10^9 Hz.). Note: Throughout these documents we have used the abbreviation 'µwave' to denote Microwave.

What We Claim Is:

1. A Microwave linear thermal continuous flow water heater comprising a rounded conical form chamber (resembling a standard household electric light bulb) See figure 2 of appended drawings.

2. A chamber into which µwave energy is released by two air-cooled magnetrons mounted on the top of the chamber (figure 7 defines their position). The chamber contains a specially developed silica coil, one of the properties of which being that it is flexible and therefore allowing it to be placed inside the chamber and to be coiled in helical fashion to a conical shape, being gravity balanced and self-supported. (figure 3 shows, in cut-away form, the position of the coil within the chamber)

3. A Microwave chamber that does not give rise to standing wave formation due to its special rounded conical design. The base of the chamber serving as a reflecting dish to direct the µwave energy towards the peripherally mounted coil. The absence of any right angles within the chamber gives rise to reflected energy only and is totally absent of any refracted and diffracted energy.

4. The 1 centimetre internal diameter of the silica coil gives rise to the water molecules natural frequency to interact in linear motion. Hence total linear thermal distribution of the incoming µwave energy is achieved.

5. A cold water supply, from any household's incoming mains supply is applied to the input port of the coil. Hot water exiting from the output port can be directly fed to that same household's hot what system without the need for bulk storage.

Am ndments to the claims hav been filed as follows

1. An apparatus for producing a continuous flow of hot water comprising;
a source of electromagnetic energy in the microwave spectrum provided by one or more magnetrons;
a truncated, rounded conical sealed microwave chamber containing a coiled flexible silica tube through which the water to be heated is passed:
an inlet and outlet port to terminate the silica tube ends and to interface with the cold water source and the heated water utilisation system.

2. The apparatus of Claim 1 wherein the microwave chamber is of pressed stainless steel construction having a base of concave section to reflect microwave energy towards the internal coiled silica tube; where no adjacent surfaces are at right angles which would otherwise give rise to refracted and diffracted energy.

3. The apparatus defined in Claim 1 and utilising a chamber as in Claim 2 which contains a silica coil wound to cover the internal surface of the microwave chamber and that is contained wholly within the chamber and of which the internal diameter is nominally one centimetre to achieve total linear thermal distribution within the water flowing in it.

4. A microwave linear thermal continuous flow water heating apparatus as described with reference to the accompanying drawings.

Application No: GB 0028807.6
Claims searched: 1-3

Examiner: John Cockitt
Date of search: 7 February 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): H5H [HMB, HMQ, HMX]; F4A [ADD, AHA]

Int Cl (Ed.7): H05B [6/78, 6/80]; F24H [1/10, 1/16]

Other: ONLINE: EPODOC, WPI, JAPIO, INSPEC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	US5286939A	MARTIN	
A	US4751359A	JAMIESON	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		